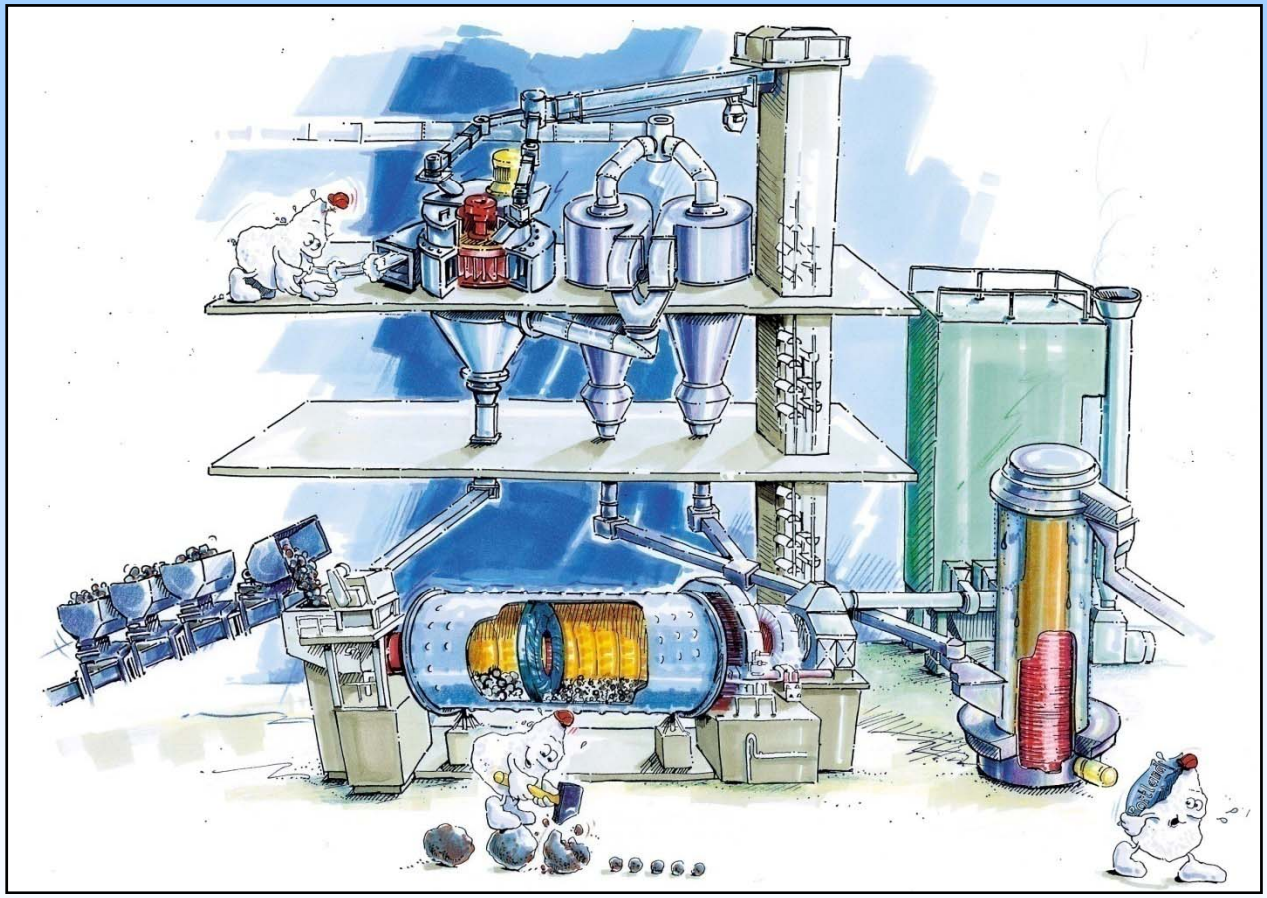
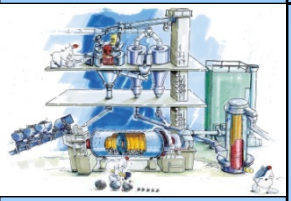
Ball mill inspection procedure



Tim Nowack

Senior Process Engineer

Christian Pfeiffer Maschinenfabrik GmbH



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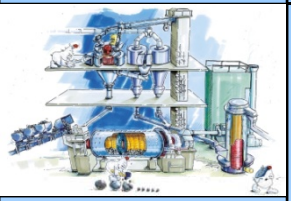
General:

The process engineer should be the doctor of the system.

The "doctor" is required for:

1) implementation of "Health checks"
   ➔ Regular action
2) urgent investigations of actual process problems
   ➔ Non-regular action

This presentation focuses on the regular "Health check" procedure.



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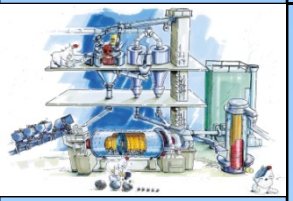
General:

The “Health checks”consist of standard measurements on a frequent basis

Type of measurement:	12 months schedule											
Circuit mat. granulometry				●								
Mill longitudinal sieving	●			●			●			●		
Ball charge filling degree	●			●			●			●		
Mill material level	●			●			●			●		
Mill internal conditions	●			●			●			●		
Ball charge sampling				●								
Separator Tromp curve				●								
Separator ventilation				●								
Mill ventilation				●								
Weigh feeder calibration				●								
Instrument verification	●			●			●			●		
Control loop verification				●								

Main annual audit



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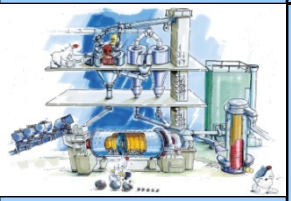
General:

“Healths checks” are important in order to:

- **build up a knowledge and data base about the system performance**
- **record the data and display them in trends for fast and easy diagnostic of problems**

The main advantage:

Knowledge basis allows to investigate the root cause of problems and to avoid problems by early reaction based on the trend results.



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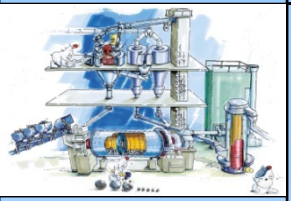
General:

For each measurement make sure you have:

- **design data of the machines/equipment available.**
- **constant/stable operation condition for at least 2 hours.**
- **recorded the actual operation data like:**
  - Production rate [t/h], Product type, composition [M-%]
  - Actual and target fineness of product [Blaine or Residue]
  - Actual mass flow rate (e.g. separator grits, water demand, etc.)
  - Electrical power consumption of the main equipment
  - Actual operation parameter of the main equipment (e.g. separator speed, damper positions)



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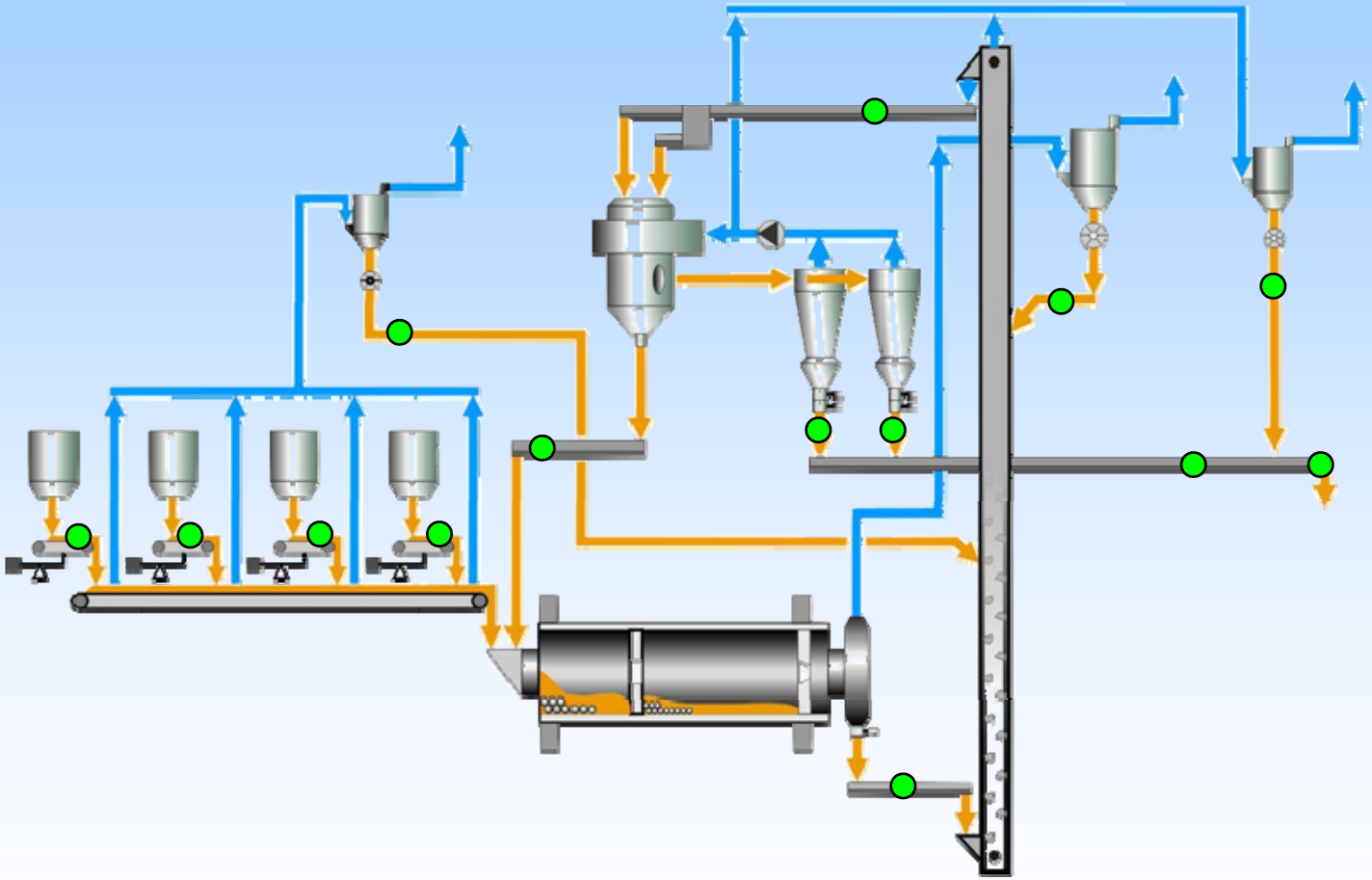
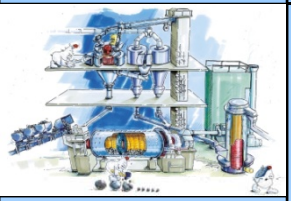
Circuit material granulometry:

Sampling points





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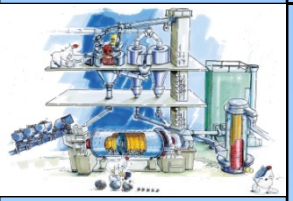
Circuit material granulometry:

Sampling point:	✹	🕐	**Procedures**	
Clinker feed	10 kg	1 x per Test	🌡	Sieving
Gypsum feed			H_2O	50, 25, 16, 8, 4, 2, 1, [mm]
Additive No.1 feed			H_2O	
Additive No. 2 feed			H_2O	
Mill outlet material	0.5 kg	1 x every hour	🌡	Pre-screening with 450 µm sieve
Separator feed material			🌡	
Separator grits material			🌡	
Separator fines cyclone 1			🌡	PSD from 1-450 µm with Laser equipment (e.g. Cilas, Malvern, Sympatec)
Separator fines cyclone 2			🌡	
Separator fines mix			🌡	
Filter dust 1 (weighfeeder)			🌡	
Filter dust 2 (circuit dedusting)			🌡	
Filter dust 3 (mill dedusting)			🌡	Fineness acc. to Blaine [cm^2/g]
Cement			🌡	



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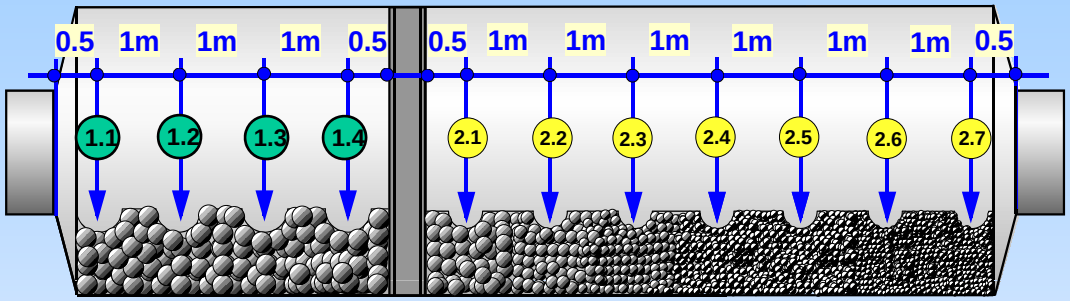
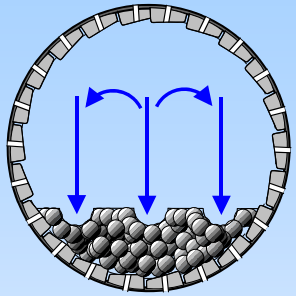
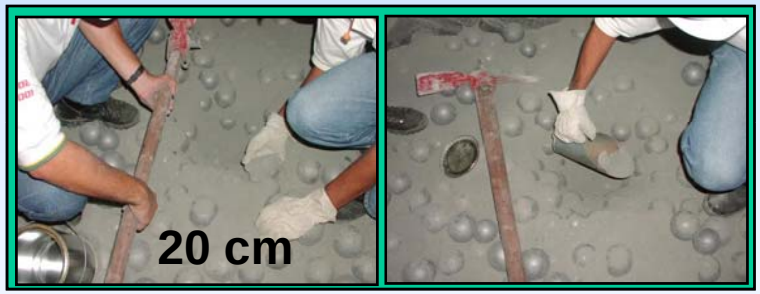
Longitudinal sampling:

Sampling points at crash stop



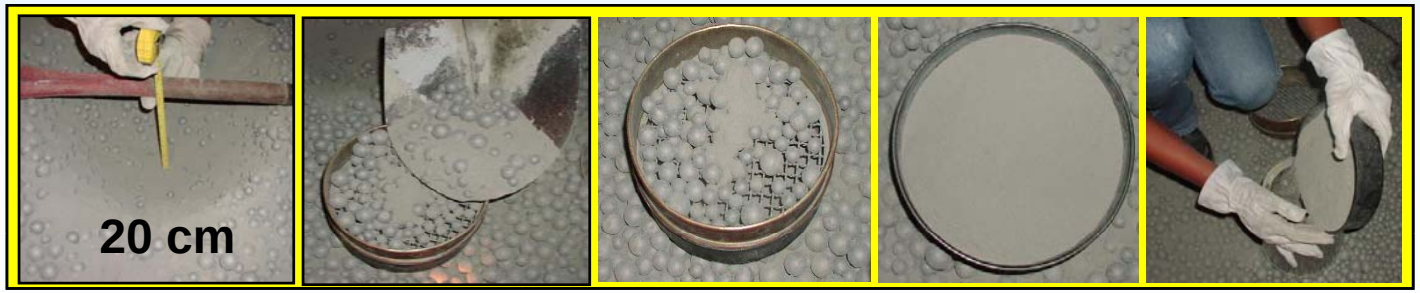


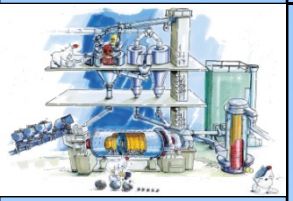


Sample weight:

1st compartment: 1-2 kg

2nd compartment: 0.5 kg





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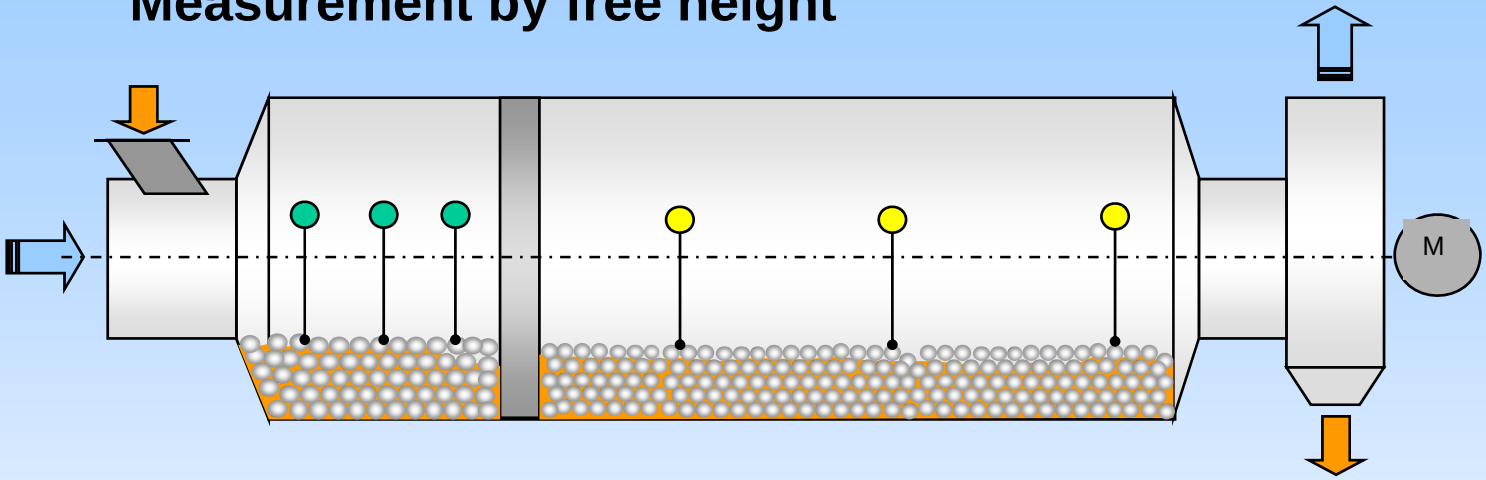
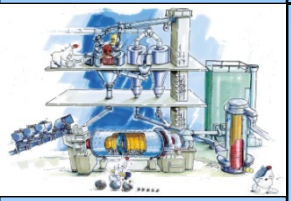
Ball charge filling degree:

Measurement by free height



1. **Measure average internal diameter, D_i**
2. **Measure height, h, in three different points along axis for each grinding compartment**

For best results the measurement takes place in an empty mill (mill feed stopped for approx. 10 min).



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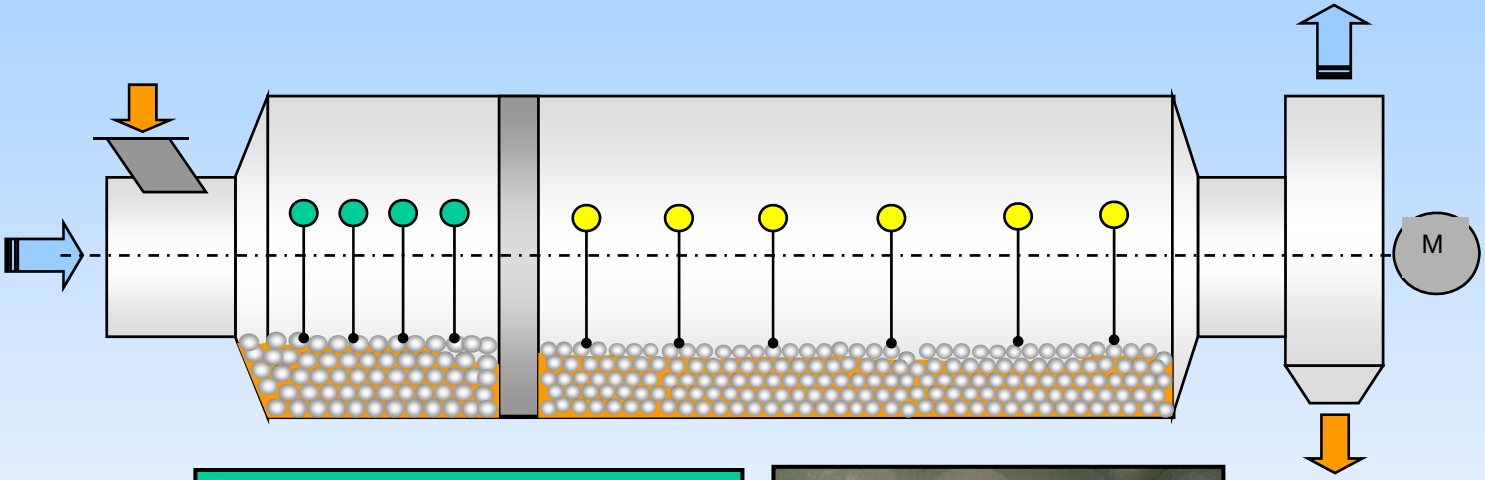
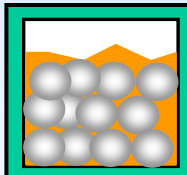
Mill material level:

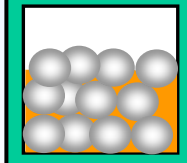
Inspection only at crash stop

Record the material level approx. each meter along axis

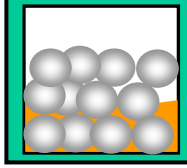




Too high = above charge

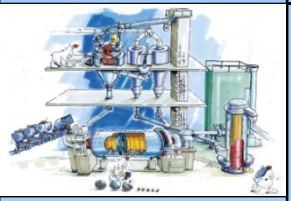


Good = ½ Ø below charge



Too low = >1 Ø below charge

Good material level for 1st compartment



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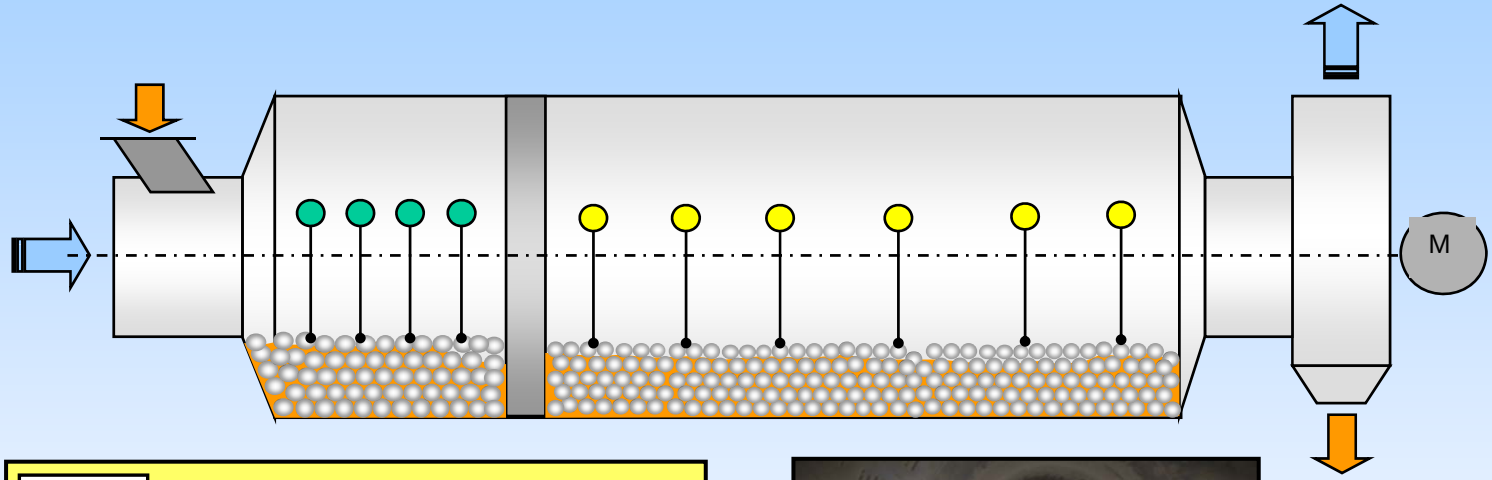
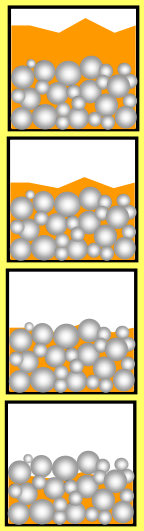
Mill material level:

Inspection only at crash stop

Record the material level approx. each meter along axis





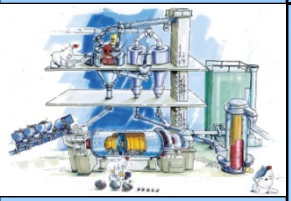
Too high = > 50mm above charge

Good = approx. 20 mm above charge

Moderate = equal with ball charge

Too low = >> 50 mm below charge

Good material level for 2nd compartment



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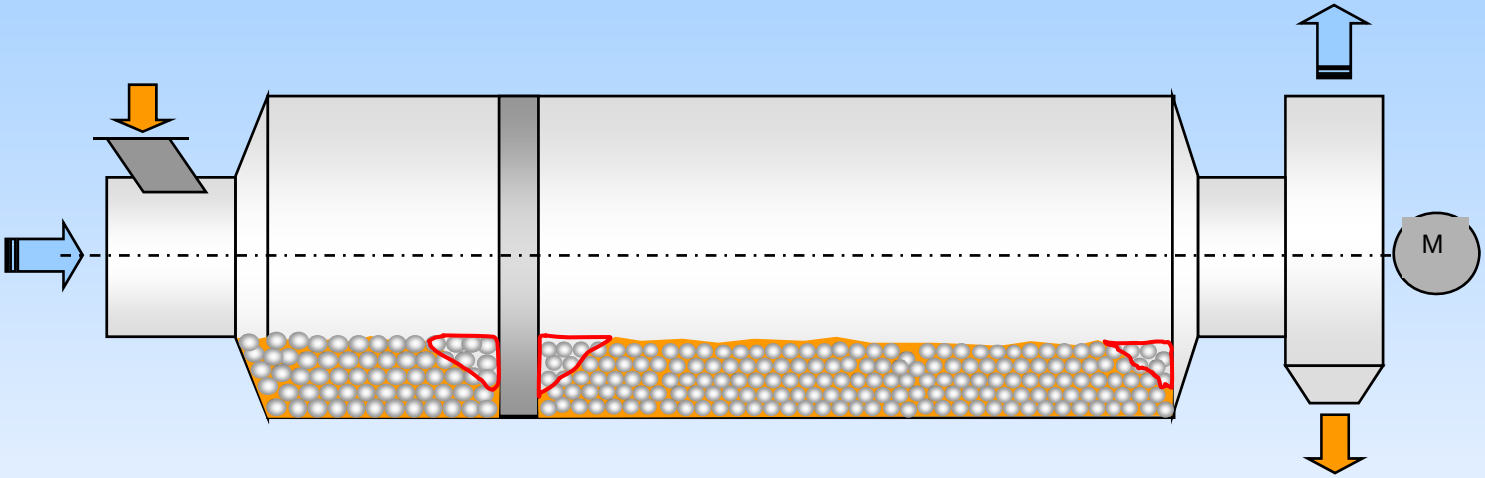
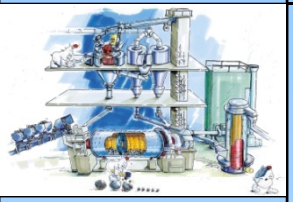
Mill material level:

Inspection only at crash stop

Record the material level before and after **transfer points**





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Mill internals condition:

Crash stop information:

Type of product: **OPC**

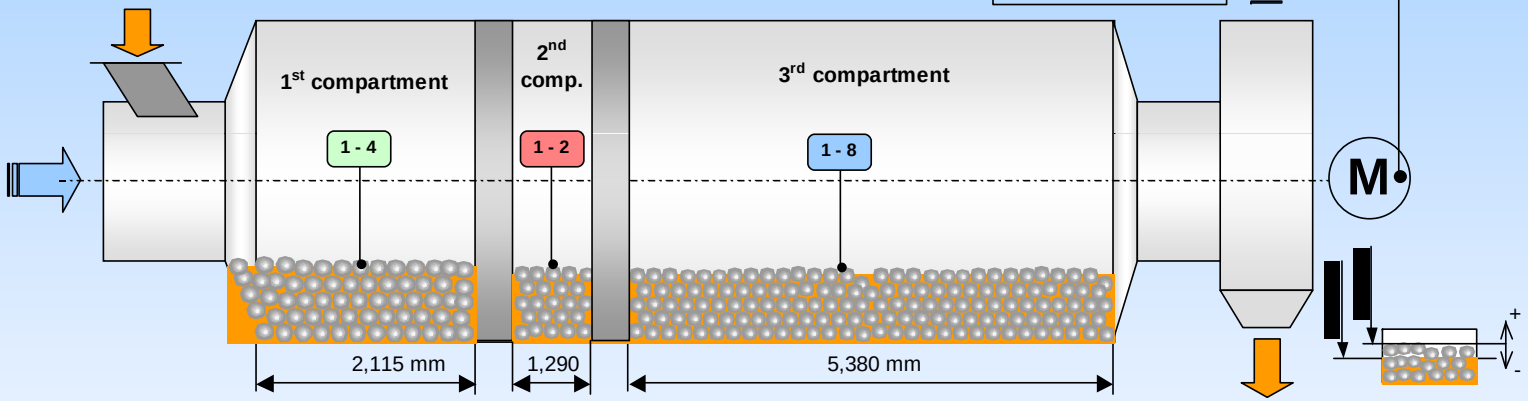
Total mill feed:	n.a.	[t/h]
Fresh feed:	n.a.	[t/h]
Coarse return:	n.a.	[t/h]

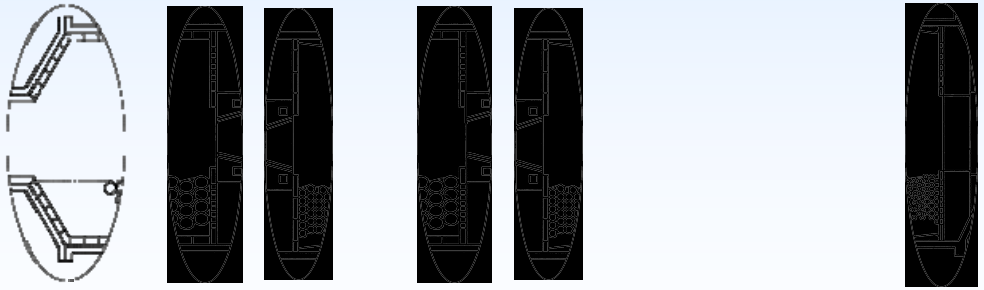
Finish mill No. 2
Ø 3,5 m x 9,6 m

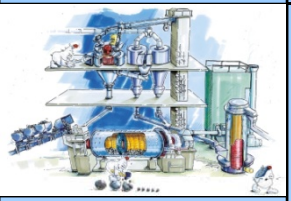
Main mill drive:

power installed	1495	[kWh]
power absorbed	n.a.	[kWh]
mill speed	16,72	[r.p.m.]
critical speed	72,67	[%]

Free heightcalculation:
Pabs= 1247 kW







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Mill internals condition:

MILL SHELL LINING SYSTEM:

1ST compartment:

Type of lining:	Wave liners (5 rows)
Type of fastening:	bolted
Condition:	Worse / Rem. lifting heigth 50-65mm
Remarks:	Many broken plates - scraps in gaps
	None DIN type

Measurement Point	Free Height above charge	Material level	Ball sizes
1	2,260	one side approx. 30mm below	90 - 50
2	-		
3	-		
4	-		
AVG.	2,260	FG = 28,2%	

2ND compartment:

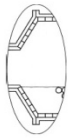
Type of lining:	Wave liners (3 rows)
Type of fastening:	bolted
Condition:	Good condition - some
Remarks:	Average lifting heigth :
	Poor Material level

3RD compartment:

Type of lining:	Drag Peb lining with Da
Type of fastening:	semi bolted / Danula rin
Condition:	Mechanical good condit
Remarks:	Small balls in gaps betv
	plates

Name	MILL DATA SHEET	Instal
Now		Mill D
Date	Project No. -	Custo
09.06.2005	Country	Plant

MILL DIAPHRAGMS:



HEAD LINER

	inner diameter <------> outer diameter			
Lining ring	1	2	3	4
Number of plates per ring	8	16	16	16
Base Thickness	x	x	x	x
Residual Thickness	65 mm	40-70	50-80	50-70
Lifter height	n.a.	n.a.	n.a.	n.a.
Number of bolts per plate	2	2	2	2
Remark	-	worn out broken plates replaced plates	-	-
Ø mill inlet	1,005 mm			
Type of mill head	conical			

INTERMEDIATE DIAPHRAGM NO.1

	inner diam
Lining ring	1
Number of plates per ring	8
Base Thickness	x
Residual Thickness	30-40
Lifter height	n.a.
Number of bolts per plate	4
Slot type	circum.
Slot width	2-9,5
Open area	~95%
Remark	mesh Ø 490mm
Material flow control	
Widt of diaphragm	
Condition of structure	
Ø-Centre opening	

Name	MILL DATA SHEET	Installation	Fir
Now		Mill Dimensions	Ø
Date	Project No. -	Customer	
09.06.2005	Country	Plant	

MILL DIAPHRAGMS:

INTERMEDIATE DIAPHRAGM NO.2

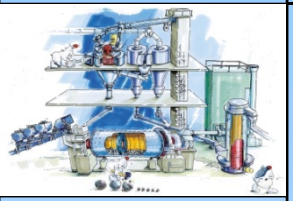
	Frontside				Backside			
	inner diameter <------> outer diameter				inner diameter <------> outer diameter			
Lining ring	1	2	3	4	1	2	3	4
Number of plates per ring	8	16	-	-	8	16	-	-
Base Thickness	x	x	-	-	x	x	-	-
Residual Thickness	20-40	20-35	-	-	65-80	65-80	-	-
Lifter height	n.a.	n.a.	-	-	n.a.	n.a.	-	-
Number of bolts per plate	4	3	-	-	4	3	-	-
Slot type	circum.	circum.	-	-	n.a.	n.a.	-	-
Slot width	4-10	5-11	-	-	n.a.	n.a.	-	-
Open area	100%	95%	-	-	n.a.	n.a.	-	-
Remark	mesh Ø 490mm	-	-	-	-	-	-	-
Material flow control	n.a.							
Widt of diaphragm	x							
Condition of structure	mechanical acceptable condition							
Ø Centre opening	1000 mm				1010 mm			

DISCHARGE DIAPHRAGM

	inner diameter <------> outer diameter			
Lining ring	1	2	3	4
Number of plates per ring	8	16	-	-
Base Thickness	x	x	-	-
Residual Thickness	25-40	20-35	-	-
Lifter height	n.a.	n.a.	-	-
Number of bolts per ring	4	4	-	-
Slot type	radial	radial	-	-
Slot width	5-6	5-8	-	-
Open area	100%	~80%	-	-
Remark	centre screen with small free area	-	-	-

Widt of diaphragm	x
Condition of structure	good
Ø-Centre opening	x

Name	MILL DATA SHEET	Installation	Finish mill No. 2
Now		Mill Dimensions	Ø 3,5 m x 9,6 m
Date	Project No. -	Customer	
09.06.2005	Country	Plant	



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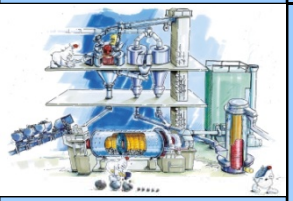
Mill internals condition:



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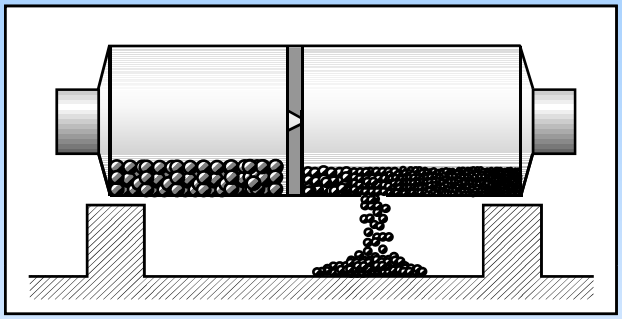
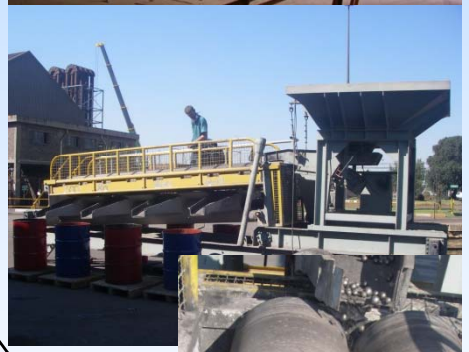
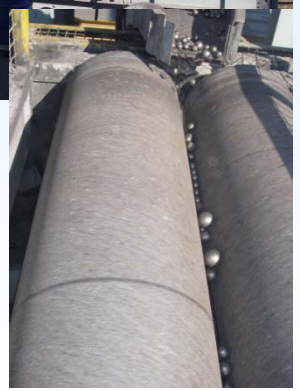
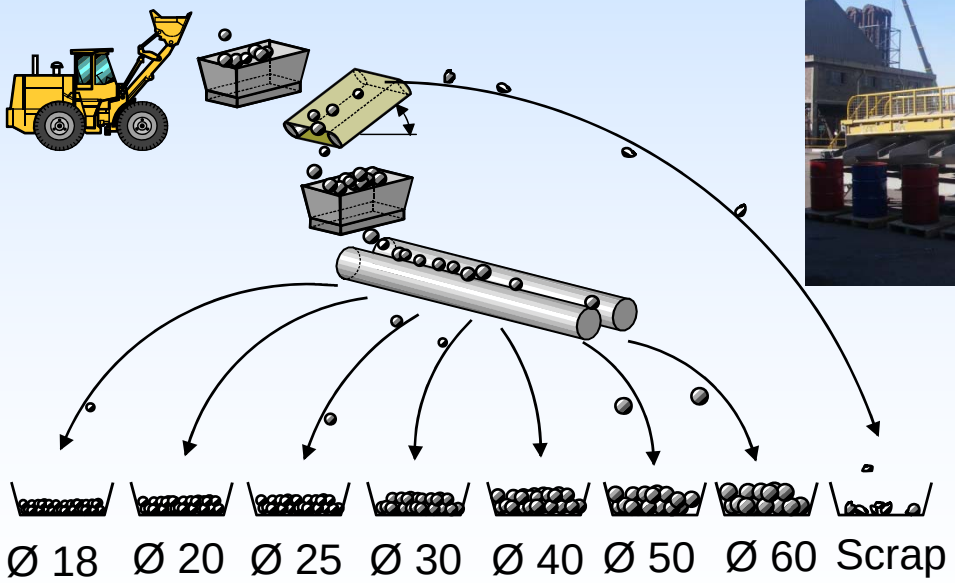
Ball charge sampling:

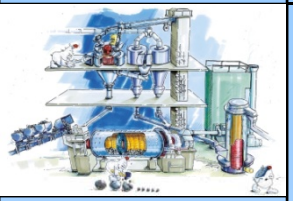
Solution 1) Total sorting of ball charge











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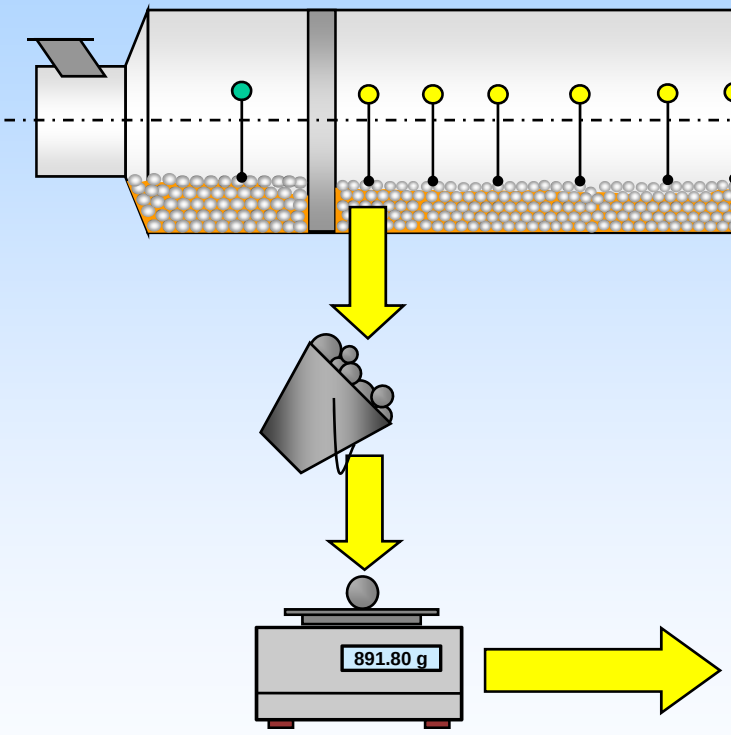
Ball charge sampling:

Solution 2) Analysing the actual grinding media composition by spot samples.



1st compartment:

50 balls per sample

2nd compartment:

200 balls per sample

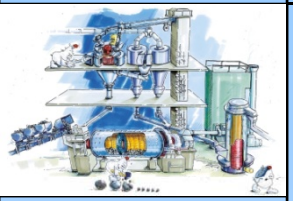
Christian Pfeiffer — Avg. Piece Weight — Input Table — Date: 23.02.2006 — Prepared by: Now

Customer Data:

Project-No.:	33.420
Project:	-
Customer:	-
Plant:	-
Installation:	Ø2.4m x 5.0m with QDK 8,5-F
Compartment:	Monochamber (1/3 lifter - 2/3 class.)

Grinding balls

Ball - Ø		60	50	40	30	25	20
	Std.	886 g	513 g	262 g	111 g	64 g	33 g
	Max	1400,0 g	681,0 g	374,0 g	176,0 g	80,0 g	44,0 g
	Min	682,0 g	375,0 g	177,0 g	81,0 g	45,0 g	14,0 g
Piece	Mass						
1	891,8 g	891,8 g					
2	886,2 g	886,2 g					
3	879,6 g	879,6 g					
4	878,0 g	878,0 g					
5	873,5 g	873,5 g					
6	873,3 g	873,3 g					
7	861,0 g	861,0 g					
8	860,6 g	860,6 g					
9	858,2 g	858,2 g					



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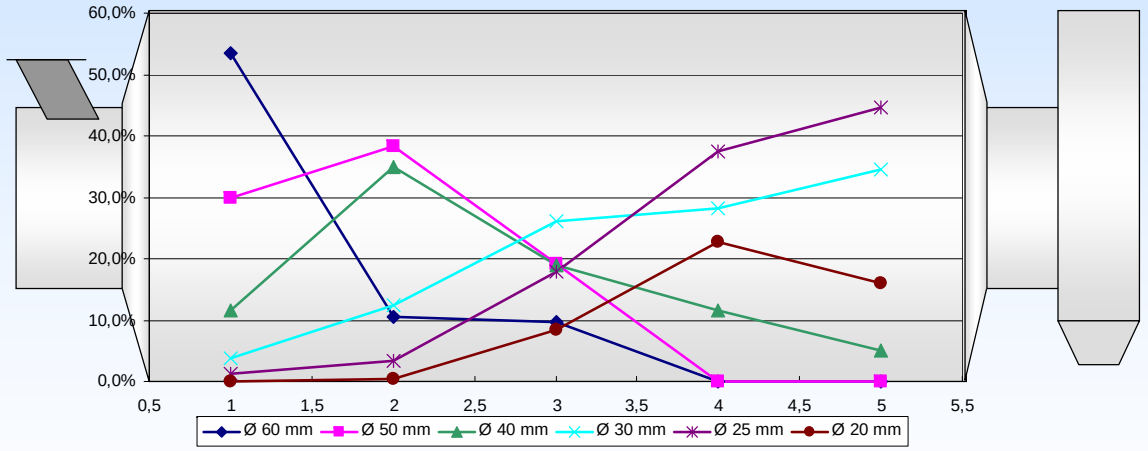
Ball charge sampling:

Solution 2) Analysing the actual grinding media composition by spot samples.

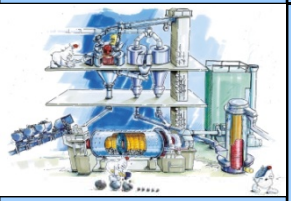
Results of grinding media sampling

Ball Ø	Sampling Point 1			2			3			4			5		
	pc.	weight	mass-%	pc.	weight	mass-%	pc.	weight	mass-%	pc.	weight	mass-%	pc.	weight	mass-%
60	24	19920	53,56%	3	2552	10,54%	3	2353	9,68%	0	0	0,00%	0	0	0,00%
50	23	11112	29,88%	20	9269	38,28%	10	4651	19,13%	0	0	0,00%	0	0	0,00%
40	18	4293	11,54%	35	8468	34,97%	19	4592	18,88%	5	1209	11,58%	4	952	4,96%
30	13	1384	3,72%	28	2997	12,38%	59	6328	26,02%	28	2943	28,19%	63	6617	34,46%
25	8	481	1,29%	14	835	3,45%	73	4369	17,97%	66	3923	37,57%	144	8576	44,67%
20	0	0	0,00%	3	93	0,39%	66	2025	8,33%	76	2366	22,66%	98	3056	15,91%
Total	86	37190	100,00%	103	24215	100,00%	230	24316	100,00%	175	10441	100,00%	309	19200	100,00%



Name	Avg. Piece Weight	Installation	-
Now		Mill dimensions	-
Date	Project. No. 33.420	Customer	-
23.02.2006	Country -	Plant	-

Christian Pfeiffer
Systems and components



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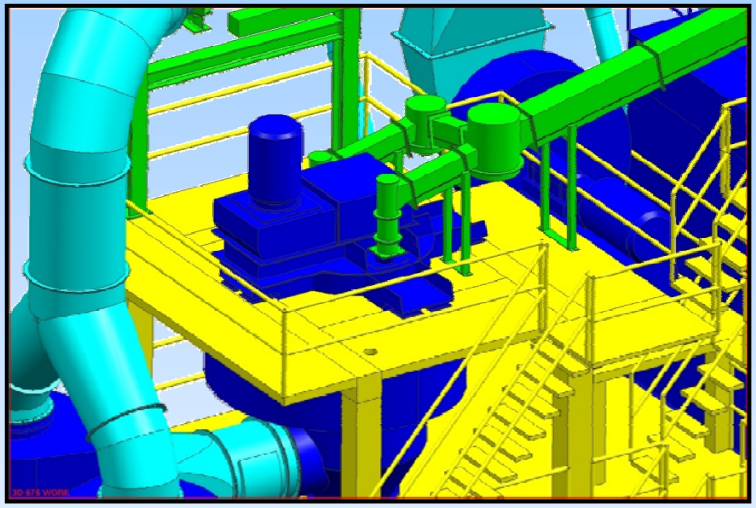
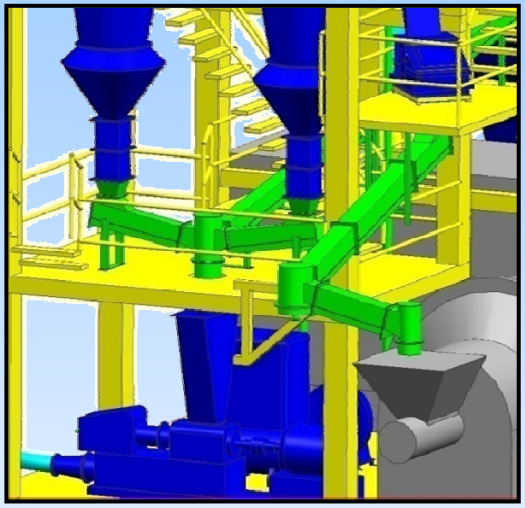
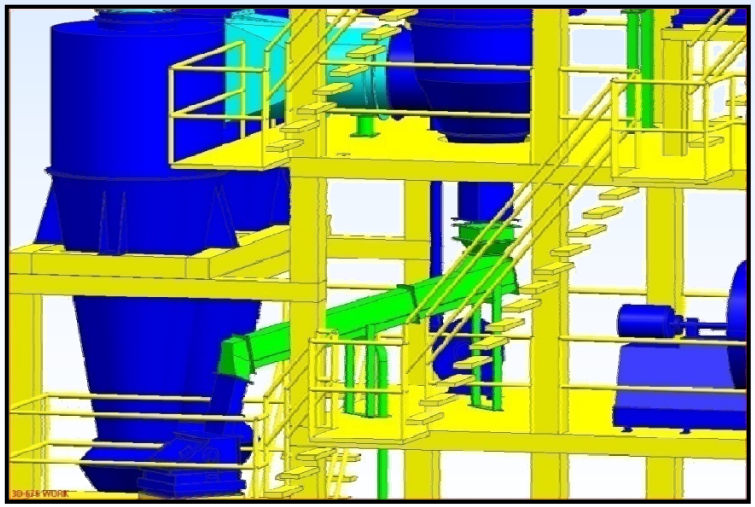
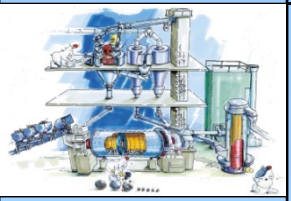
Separator tromp curve:

Define the sampling points









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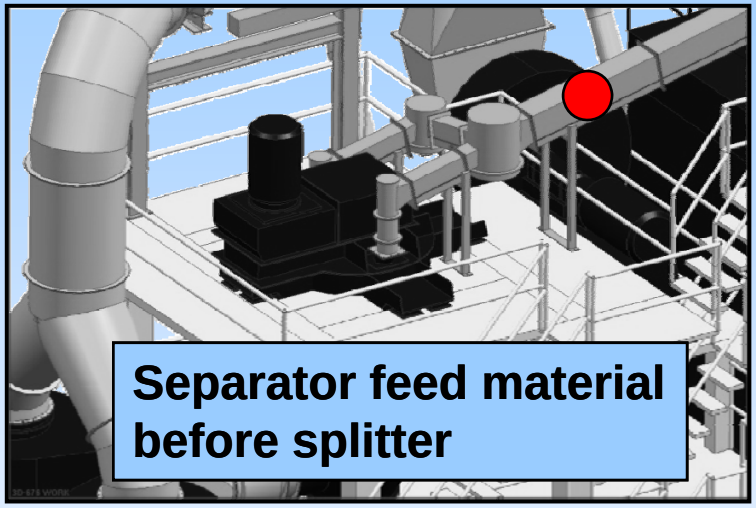
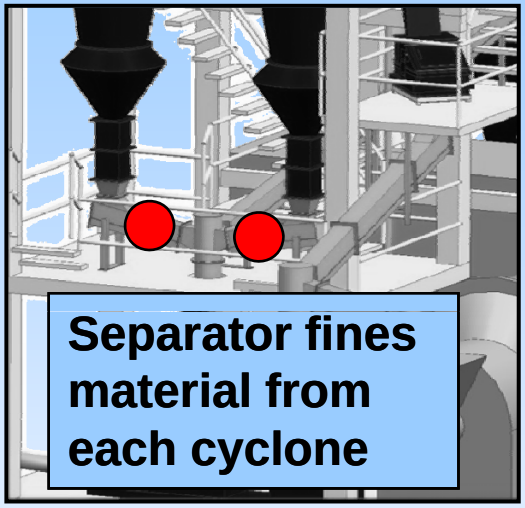
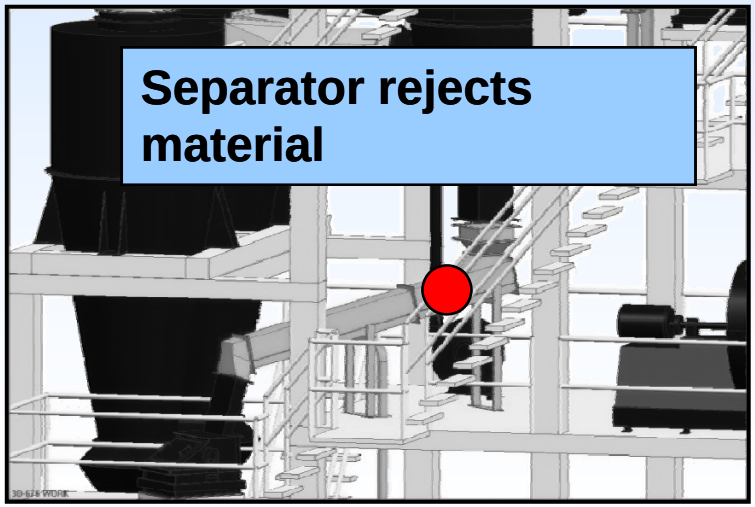
Separator tromp curve:

Define the sampling points



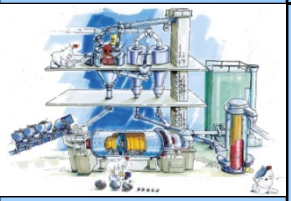




and

Check the stable condition of the circuit

Record all main operation parameters



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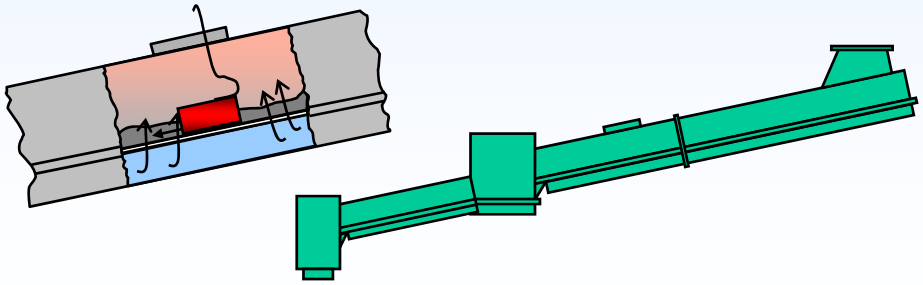
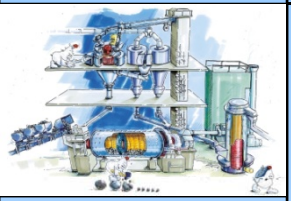
Separator tromp curve:

Define the sampling points

Sampling point:	✹	🕐	Procedures	
Separator feed material	0.5 kg	1 x every hour	🌡	Pre-screening with 450 µm sieve
Separator grits material			🌡	PSD from 1-450 µm with Laser equipment (e.g. Cilas, Malvern, Sympatec)
Separator fines cyclone 1			🌡	
Separator fines cyclone 2			🌡	Fineness acc. to Blaine [cm²/g]





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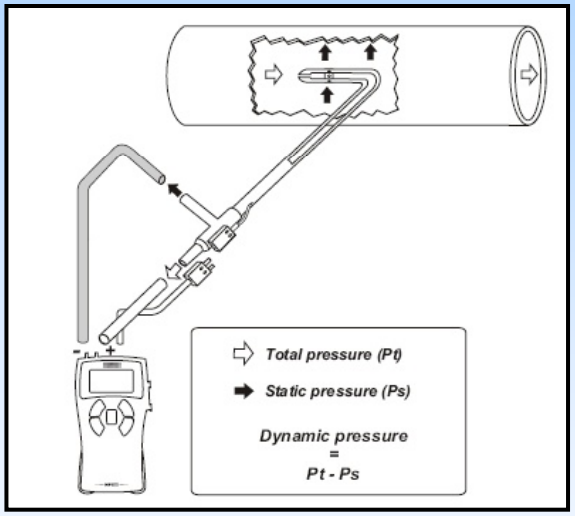
Separator Ventilation:

Basics: Air flow measurement

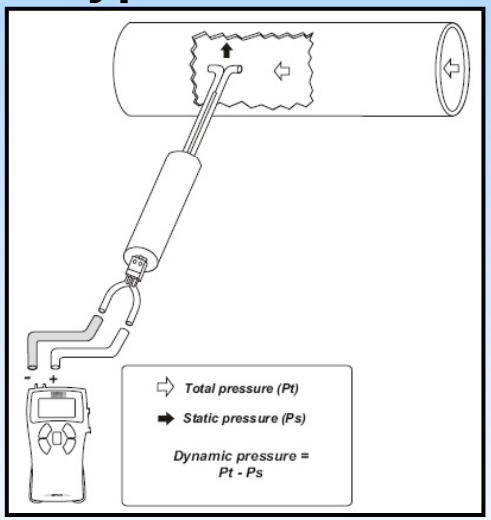
Select your equipment

Prandtl-Pitot Tube

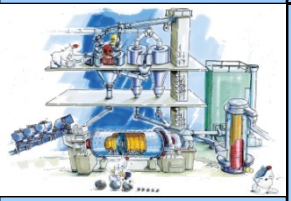


- No correction factor needed
- Easy to operate within 15° angle
- Only in low vortex channel
- Not for high dust loaded channels

S-Type Tube



- Correction factor required (~0.84)
- Misalignment results in mistakes
- Preferred for high dust loaded channels



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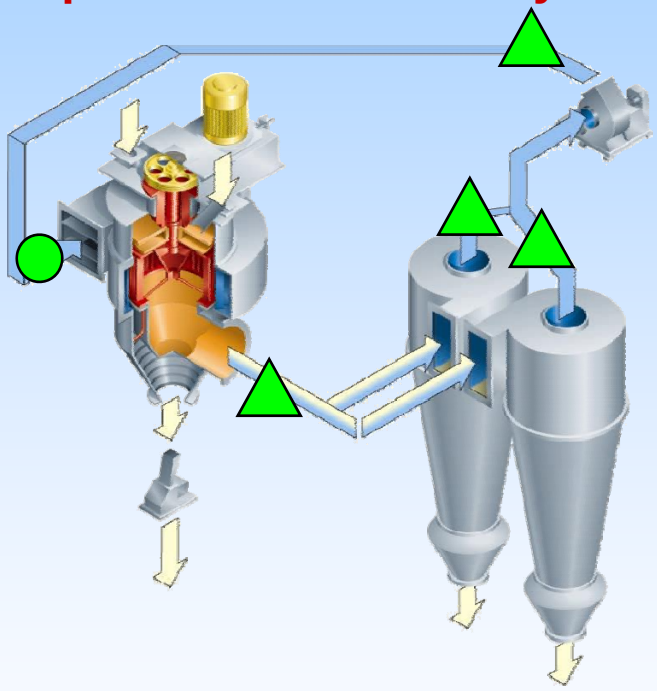
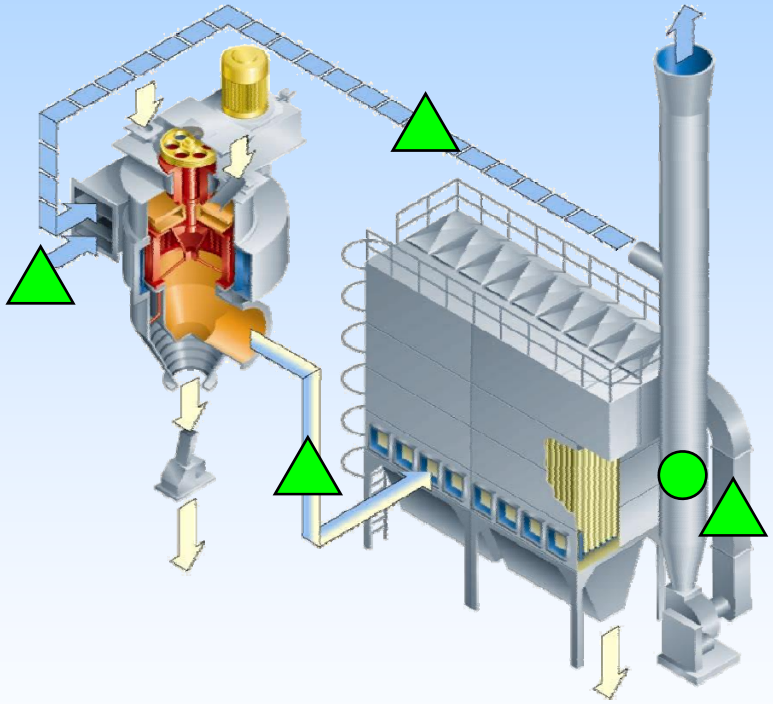
Separator Ventilation:

Measurement points:

Separator circuit with cyclones

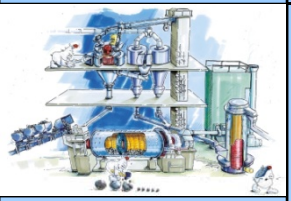


Separator circuit with filter



= Air flow, Static pressure, Temperature

= Static pressure, Temperature



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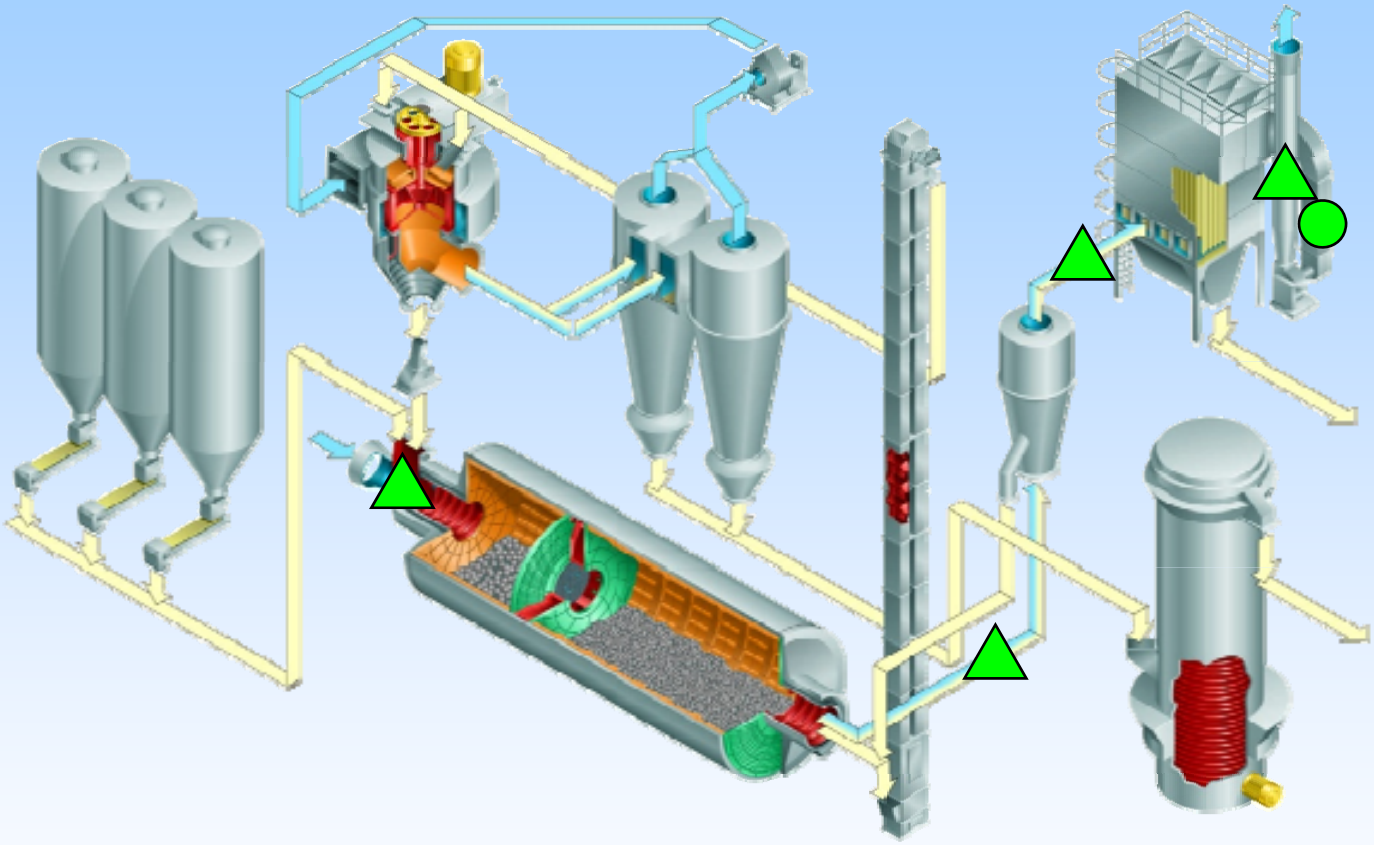
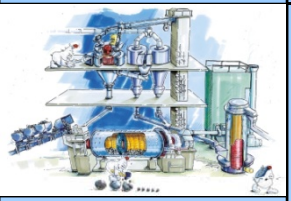
Mill Ventilation:



= Air flow, Static pressure, Temperature

= Static pressure, Temperature

Remark: Consider minimum 10% false air intake after mill.



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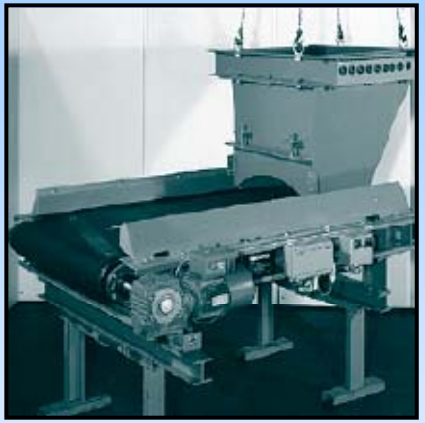
Weigh Feeder Calibration:

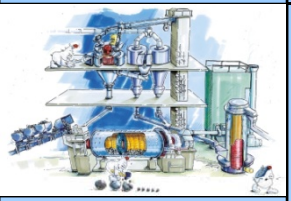
a) Static calibration - feeder not in operation

- Zero-point - adjustment (local control box, no load)
- Span adjustment with calibration weight (local control box)



b) Calibration with feeder in operation (preferred if possible)

- operate weigh feeder with defined setpoint and load material into truck for e.g. 10 minutes, while mill is shut down
- weigh truck empty and loaded, calculate throughput and adjust controller if necessary



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Instrument Verification:

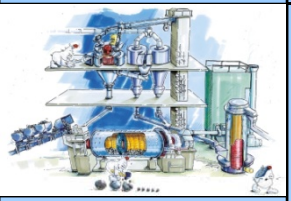
1) Electronically

- Check and adjust zero-point and span with e.g. mA-transmitter

2) Operation check

- Compare control room indication with local manual measurement of temperature, pressure and flow

➔ **Adjust transmitters**



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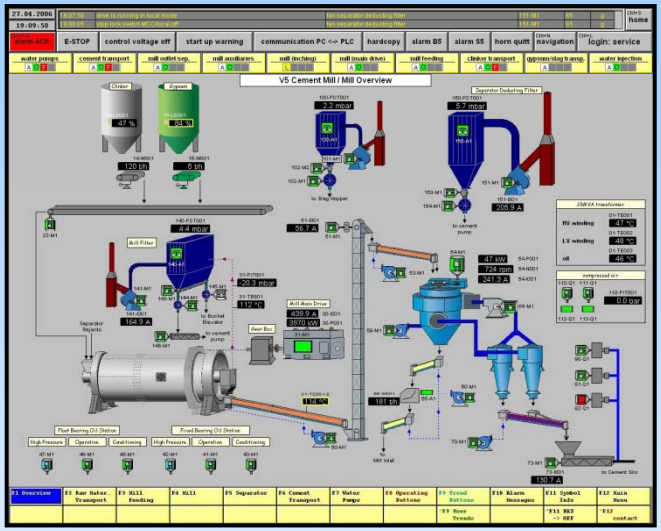
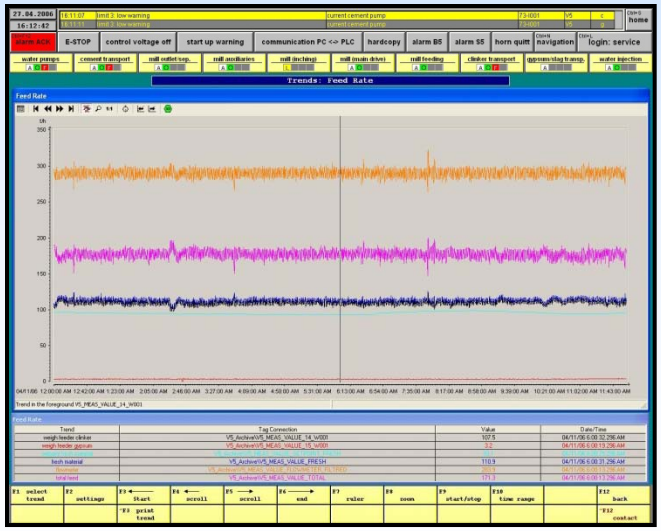
Control loop Verification:

1) Operation check

- record process parameters with control loop in operation over period of e.g. 6-8 hours with constant production
- record mill power consumption at counter (kWh)

➔ **Adjust control loop parameters if necessary**

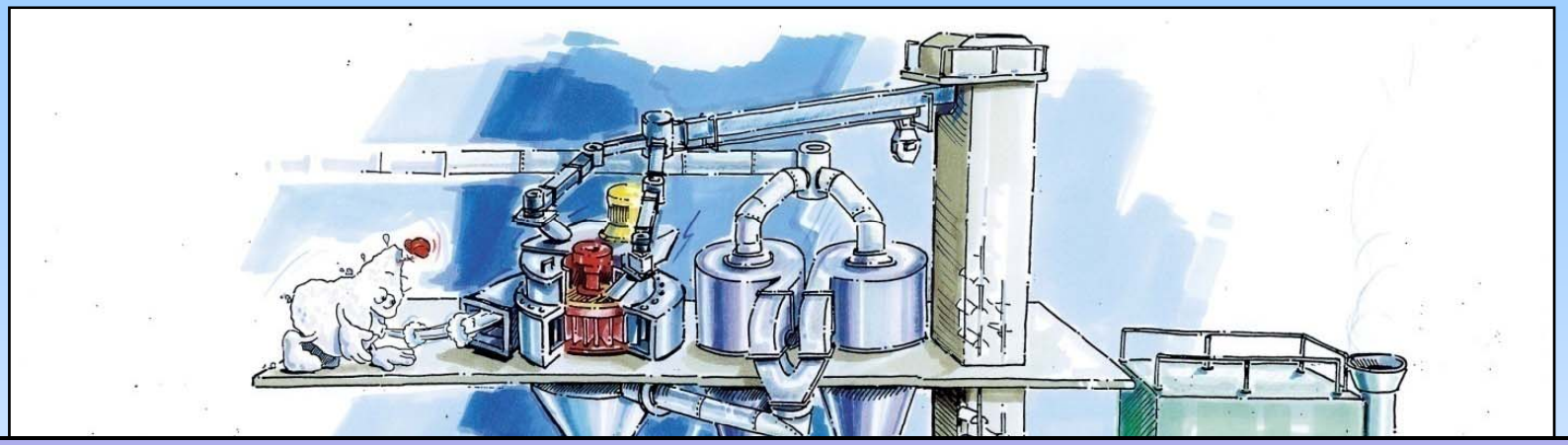




Information on:

- Available information at the CCR
- Control system
- Control strategy
- First impression on operation
- Circuit stability

Thank you for your attention



Questions?